### 1.1. D450V3 Dipole Calibration Certificate

Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





Schweizerischer Kalibrierdienst Service suisse d'étalonnage Servizio svizzero di taratura **Swiss Calibration Service** 

Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

150V0 1100 F-110

<b>ALIBRATION C</b>	ERTIFICATE		
Dbject	D450V3 - SN:1102		
Calibration procedure(s)	QA CAL-15.v8 Calibration procedure for dipole validation kits below 700 MHz		
Calibration date:	February 23, 2018	8	
The measurements and the uncer	rtainties with confidence pr	onal standards, which realize the physical uni- obability are given on the following pages and y facility: environment temperature $(22 \pm 3)^{\circ}$ C	d are part of the certificate.
Calibration Equipment used (M&T	Lancaca	a La La Continua No.	Scheduled Calibration
Primary Standards	ID#	Cal Date (Certificate No.)	Apr-18
Power meter NRP	SN: 104778	04-Apr-17 (No. 217-02521/02522)	Apr-18
Power sensor NRP-Z91	SN: 103244	04-Apr-17 (No. 217-02521)	Apr-18
Power sensor NRP-Z91	SN: 103245	04-Apr-17 (No. 217-02522)	Apr-18
	SN: 5277 (20x)	07-Apr-17 (No. 217-02528)	Apr-18
Reference 20 dB Attenuator			
Reference 20 dB Attenuator Type-N mismatch combination	SN: 5047.2 / 06327	07-Apr-17 (No. 217-02529)	
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4	SN: 5047.2 / 06327 SN: 3877 SN: 654	07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-3877_Dec17) 24-Jul-17 (No. DAE4-654_Jul17)	Dec-18 Jul-18
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4	SN: 3877 SN: 654	30-Dec-17 (No. EX3-3877_Dec17) 24-Jul-17 (No. DAE4-654_Jul17)	Dec-18 Jul-18
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards	SN: 3877 SN: 654	30-Dec-17 (No. EX3-3877_Dec17) 24-Jul-17 (No. DAE4-654_Jul17) Check Date (in house)	Dec-18
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B	SN: 3877 SN: 654 ID # SN: GB41293874	30-Dec-17 (No. EX3-3877_Dec17) 24-Jul-17 (No. DAE4-654_Jul17) Check Date (in house) 06-Apr-16 (No. 217-02285/02284)	Dec-18 Jul-18 Scheduled Check
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor E4412A	SN: 3877 SN: 654 ID # SN: GB41293874 SN: MY41498087	30-Dec-17 (No. EX3-3877_Dec17) 24-Jul-17 (No. DAE4-654_Jul17) Check Date (in house) 06-Apr-16 (No. 217-02285/02284) 06-Apr-16 (No. 217-02285)	Dec-18 Jul-18 Scheduled Check In house check: Jun-18
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4  Secondary Standards Power meter E4419B Power sensor E4412A Power sensor E4412A	SN: 3877 SN: 654 ID # SN: GB41293874 SN: MY41498087 SN: 000110210	30-Dec-17 (No. EX3-3877_Dec17) 24-Jul-17 (No. DAE4-654_Jul17) Check Date (in house) 06-Apr-16 (No. 217-02285/02284) 06-Apr-16 (No. 217-02285) 06-Apr-16 (No. 217-02284)	Dec-18 Jul-18 Scheduled Check In house check: Jun-18 In house check: Jun-18
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4  Secondary Standards Power meter E4419B Power sensor E4412A Power sensor E4412A	SN: 3877 SN: 654 ID # SN: GB41293874 SN: MY41498087	30-Dec-17 (No. EX3-3877_Dec17) 24-Jul-17 (No. DAE4-654_Jul17) Check Date (in house) 06-Apr-16 (No. 217-02285/02284) 06-Apr-16 (No. 217-02285)	Dec-18 Jul-18  Scheduled Check In house check: Jun-18 In house check: Jun-18 In house check: Jun-18
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4  Secondary Standards Power meter E4419B Power sensor E4412A Power sensor E4412A RF generator HP 8648C	SN: 3877 SN: 654 ID # SN: GB41293874 SN: MY41498087 SN: 000110210 SN: US3642U01700 SN: US37390585	30-Dec-17 (No. EX3-3877_Dec17) 24-Jul-17 (No. DAE4-654_Jul17)  Check Date (in house)  06-Apr-16 (No. 217-02285/02284) 06-Apr-16 (No. 217-02285) 06-Apr-16 (No. 217-02284) 04-Aug-99 (in house check Jun-16)	Dec-18 Jul-18  Scheduled Check In house check: Jun-18 In house check: Jun-18 In house check: Jun-18 In house check: Jun-18
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4  Secondary Standards Power meter E4419B Power sensor E4412A Power sensor E4412A RF generator HP 8648C	SN: 3877 SN: 654 ID # SN: GB41293874 SN: MY41498087 SN: 000110210 SN: US3642U01700	30-Dec-17 (No. EX3-3877_Dec17) 24-Jul-17 (No. DAE4-654_Jul17)  Check Date (in house)  06-Apr-16 (No. 217-02285/02284) 06-Apr-16 (No. 217-02285) 06-Apr-16 (No. 217-02284 04-Aug-99 (in house check Jun-16) 18-Oct-01 (in house check Oct-17)	Dec-18 Jul-18  Scheduled Check In house check: Jun-18 In house check: Jun-18 In house check: Jun-18 In house check: Jun-18 In house check: Oct-18
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4  Secondary Standards Power meter E4419B Power sensor E4412A Power sensor E4412A RF generator HP 8648C Network Analyzer HP 8753E	SN: 3877 SN: 654 ID # SN: GB41293874 SN: MY41498087 SN: 000110210 SN: US3642U01700 SN: US37390585 Name	30-Dec-17 (No. EX3-3877_Dec17) 24-Jul-17 (No. DAE4-654_Jul17)  Check Date (in house)  06-Apr-16 (No. 217-02285/02284) 06-Apr-16 (No. 217-02285) 06-Apr-16 (No. 217-02284 04-Aug-99 (in house check Jun-16) 18-Oct-01 (in house check Oct-17)	Dec-18 Jul-18  Scheduled Check In house check: Jun-18 In house check: Jun-18 In house check: Jun-18 In house check: Jun-18 In house check: Oct-18

Certificate No: D450V3-1102\_Feb18

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#### **Calibration Laboratory of**

Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





S Schweizerischer Kalibrierdienst
Service suisse d'étalonnage
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Accreditation No.: SCS 0108

S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)

The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

#### Glossary:

TSL

tissue simulating liquid

ConvF N/A sensitivity in TSL / NORM x,y,z not applicable or not measured

### Calibration is Performed According to the Following Standards:

 a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013

b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016

c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010

d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### **Additional Documentation:**

e) DASY4/5 System Handbook

#### Methods Applied and Interpretation of Parameters:

- Measurement Conditions: Further details are available from the Validation Report at the end
  of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed
  point exactly below the center marking of the flat phantom section, with the arms oriented
  parallel to the body axis.
- Feed Point Impedance and Return Loss: These parameters are measured with the dipole
  positioned under the liquid filled phantom. The impedance stated is transformed from the
  measurement at the SMA connector to the feed point. The Return Loss ensures low
  reflected power. No uncertainty required.
- Electrical Delay: One-way delay between the SMA connector and the antenna feed point.
   No uncertainty required.
- SAR measured: SAR measured at the stated antenna input power.
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Certificate No: D450V3-1102\_Feb18

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#### **Measurement Conditions**

DASY system configuration, as far as not given on page 1

DASY Version	DASY5	V52.10.0
Extrapolation	Advanced Extrapolation	
Phantom	ELI4 Flat Phantom	Shell thickness: 2 ± 0.2 mm
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	450 MHz ± 1 MHz	

**Head TSL parameters**The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	43.5	0.87 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	43.7 ± 6 %	0.87 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	1.12 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	4.48 W/kg ± 18.1 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	0.749 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	3.00 W/kg ± 17.6 % (k=2)

**Body TSL parameters**The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	56.7	0.94 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	56.0 ± 6 %	0.93 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

#### SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	1.11 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	4.47 W/kg ± 18.1 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	0.749 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	3.01 W/kg ± 17.6 % (k=2)

#### Appendix (Additional assessments outside the scope of SCS 0108)

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	59.6 Ω - 0.2 jΩ
Return Loss	- 21.1 dB

#### **Antenna Parameters with Body TSL**

Impedance, transformed to feed point	55.1 Ω - 6.9 jΩ	
Return Loss	- 21.8 dB	

#### **General Antenna Parameters and Design**

Electrical Delay (one direction)	1.348 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

#### **Additional EUT Data**

Manufactured by	SPEAG	
Manufactured on	October 05, 2017	

#### **DASY5 Validation Report for Head TSL**

Date: 23.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 450 MHz D450V3; Type: D450V3; Serial: D450V3 - SN:1102

Communication System: UID 0 - CW; Frequency: 450 MHz

Medium parameters used: f = 450 MHz;  $\sigma = 0.87 \text{ S/m}$ ;  $\varepsilon_r = 43.7$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY52 Configuration:

• Probe: EX3DV4 - SN3877; ConvF(10.5, 10.5, 10.5); Calibrated: 30.12.2017;

• Sensor-Surface: 1.4mm (Mechanical Surface Detection)

• Electronics: DAE4 Sn654; Calibrated: 24.07.2017

Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003

• DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

#### Dipole Calibration for Head Tissue/d=15mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:

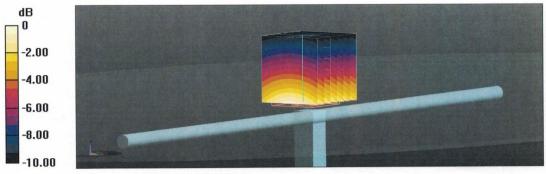
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 43.13 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 1.73 W/kg

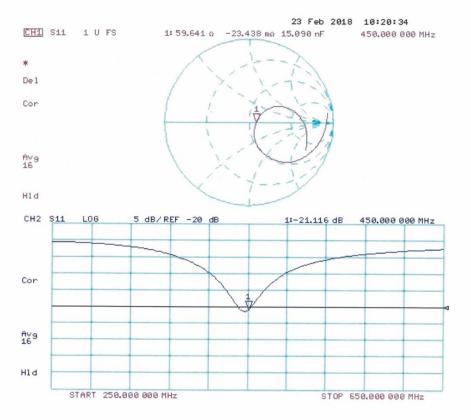
SAR(1 g) = 1.12 W/kg; SAR(10 g) = 0.749 W/kg

Maximum value of SAR (measured) = 1.51 W/kg



0 dB = 1.51 W/kg = 1.79 dBW/kg

### Impedance Measurement Plot for Head TSL



#### **DASY5 Validation Report for Body TSL**

Date: 23.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 450 MHz D450V3; Type: D450V3; Serial: D450V3 - SN:1102

Communication System: UID 0 - CW; Frequency: 450 MHz

Medium parameters used: f = 450 MHz;  $\sigma = 0.93 \text{ S/m}$ ;  $\varepsilon_r = 56$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY52 Configuration:

• Probe: EX3DV4 - SN3877; ConvF(10.8, 10.8, 10.8); Calibrated: 30.12.2017;

• Sensor-Surface: 1.4mm (Mechanical Surface Detection)

• Electronics: DAE4 Sn654; Calibrated: 24.07.2017

Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003

• DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

#### Dipole Calibration for Body Tissue/d=15mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:

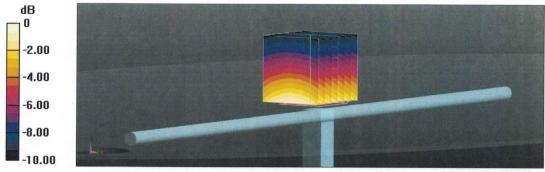
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 41.23 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 1.71 W/kg

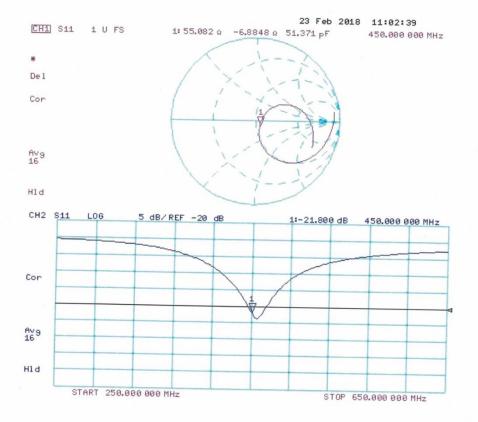
SAR(1 g) = 1.11 W/kg; SAR(10 g) = 0.749 W/kg

Maximum value of SAR (measured) = 1.50 W/kg



0 dB = 1.50 W/kg = 1.76 dBW/kg

## Impedance Measurement Plot for Body TSL



# **Extended Dipole Calibrations**

Referring to KDB865664 D01, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

Г							
	Head						
	Date of	Return-loss (dB)	Delta (%)	Real Impedance	Delta	Imaginary	Delta
	measurement	Return-1055 (db)	Della (70)	(ohm)	(ohm)	impedance (ohm)	(ohm)
Ī	2018-02-23	-21.1		59.6		-0.2	
Ī	2019-02-15	-21.8	-3.32	59.1	0.5	-0.8	0.6
Ī	2019-01-22	-21.8	-3.32	58.8	0.8	-0.5	0.3

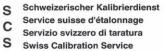
The return loss is <-20dB, within 20% of prior calibration; the impedance is within 50hm of prior calibration. Therefore the verification result should support extended calibration.

#### 1.2. D750V3 Dipole Calibration Certificate

Calibration Laboratory of Schmid & Partner **Engineering AG** Zeughausstrasse 43, 8004 Zurich, Switzerland







Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

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Client

CCIC-HTW (Auden)

Certificate No: D750V3-1180 Feb18

#### CALIBRATION CERTIFICATE D750V3 - SN:1180 Object **QA CAL-05.v9** Calibration procedure(s) Calibration procedure for dipole validation kits above 700 MHz Calibration date: February 07, 2018 This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. Calibration Equipment used (M&TE critical for calibration) ID# Cal Date (Certificate No.) Scheduled Calibration Primary Standards Power meter NRP SN: 104778 04-Apr-17 (No. 217-02521/02522) Apr-18 04-Apr-17 (No. 217-02521) Apr-18 Power sensor NRP-Z91 SN: 103244 Apr-18 Power sensor NRP-Z91 SN: 103245 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) Apr-18 Reference 20 dB Attenuator SN: 5058 (20k) 07-Apr-17 (No. 217-02529) Apr-18 Type-N mismatch combination SN: 5047.2 / 06327 Reference Probe EX3DV4 SN: 7349 30-Dec-17 (No. EX3-7349\_Dec17) Dec-18 SN: 601 26-Oct-17 (No. DAE4-601\_Oct17) Oct-18 DAE4 Secondary Standards ID# Check Date (in house) Scheduled Check In house check: Oct-18 Power meter EPM-442A SN: GB37480704 07-Oct-15 (in house check Oct-16) Power sensor HP 8481A SN: US37292783 07-Oct-15 (in house check Oct-16) In house check: Oct-18 Power sensor HP 8481A SN: MY41092317 07-Oct-15 (in house check Oct-16) In house check: Oct-18 RF generator R&S SMT-06 In house check: Oct-18 SN: 100972 15-Jun-15 (in house check Oct-16) Network Analyzer HP 8753E SN: US37390585 18-Oct-01 (in house check Oct-17) In house check: Oct-18 Name Function Claudio Leubler Laboratory Technician Calibrated by: Katja Pokovic Technical Manager Approved by: Issued: February 7, 2018 This calibration certificate shall not be reproduced except in full without written approval of the laboratory

Certificate No: D750V3-1180\_Feb18

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#### Calibration Laboratory of

Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland





S Schweizerischer Kalibrierdienst
Service suisse d'étalonnage
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Swiss Calibration Service

Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

#### Glossary:

TSL tissue simulating liquid

ConvF sensitivity in TSL / NORM x,y,z N/A not applicable or not measured

#### Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)". March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### **Additional Documentation:**

e) DASY4/5 System Handbook

#### Methods Applied and Interpretation of Parameters:

- Measurement Conditions: Further details are available from the Validation Report at the end
  of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed
  point exactly below the center marking of the flat phantom section, with the arms oriented
  parallel to the body axis.
- Feed Point Impedance and Return Loss: These parameters are measured with the dipole
  positioned under the liquid filled phantom. The impedance stated is transformed from the
  measurement at the SMA connector to the feed point. The Return Loss ensures low
  reflected power. No uncertainty required.
- Electrical Delay: One-way delay between the SMA connector and the antenna feed point.
   No uncertainty required.
- SAR measured: SAR measured at the stated antenna input power.
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna connector
- SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Certificate No: D750V3-1180\_Feb18

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#### **Measurement Conditions**

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.10.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, $dy$ , $dz = 5 mm$	
Frequency	750 MHz ± 1 MHz	

**Head TSL parameters**The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.9	0.89 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	41.4 ± 6 %	0.89 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.06 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	8.22 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.35 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	5.39 W/kg ± 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.5	0.96 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	55.2 ± 6 %	0.96 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

#### SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.14 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	8.55 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.42 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	5.68 W/kg ± 16.5 % (k=2)

#### Appendix (Additional assessments outside the scope of SCS 0108)

#### **Antenna Parameters with Head TSL**

Impedance, transformed to feed point	54.1 Ω - 0.2 jΩ
Return Loss	- 28.1 dB

#### **Antenna Parameters with Body TSL**

Impedance, transformed to feed point	49.3 Ω - 4.0 jΩ
Return Loss	- 27.7 dB

#### **General Antenna Parameters and Design**

Electrical Delay (one direction)	1.037 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

#### **Additional EUT Data**

Manufactured by	SPEAG		
Manufactured on	February 21, 2017		

#### **DASY5 Validation Report for Head TSL**

Date: 07.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN:1180

Communication System: UID 0 - CW; Frequency: 750 MHz

Medium parameters used: f = 750 MHz;  $\sigma = 0.89 \text{ S/m}$ ;  $\varepsilon_r = 41.4$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY52 Configuration:

Probe: EX3DV4 - SN7349; ConvF(10.22, 10.22, 10.22); Calibrated: 30.12.2017;

• Sensor-Surface: 1.4mm (Mechanical Surface Detection)

• Electronics: DAE4 Sn601; Calibrated: 26.10.2017

Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001

DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

#### Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

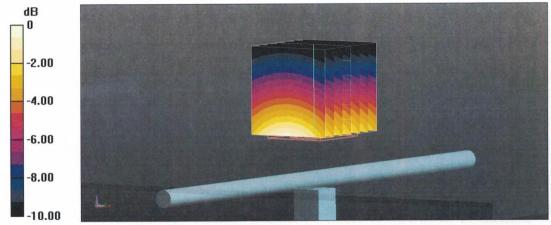
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 58.99 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 3.09 W/kg

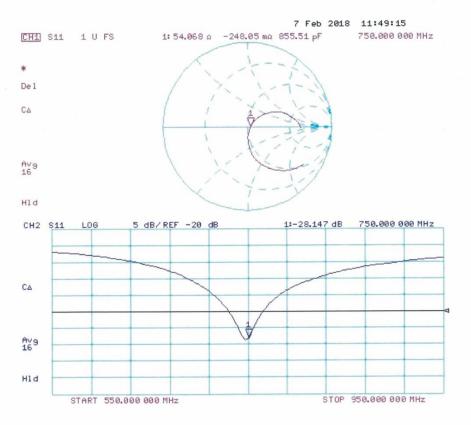
SAR(1 g) = 2.06 W/kg; SAR(10 g) = 1.35 W/kg

Maximum value of SAR (measured) = 2.75 W/kg



0 dB = 2.75 W/kg = 4.39 dBW/kg

#### Impedance Measurement Plot for Head TSL



#### **DASY5 Validation Report for Body TSL**

Date: 07.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN:1180

Communication System: UID 0 - CW; Frequency: 750 MHz

Medium parameters used: f = 750 MHz;  $\sigma = 0.96 \text{ S/m}$ ;  $\varepsilon_r = 55.2$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY52 Configuration:

• Probe: EX3DV4 - SN7349; ConvF(10.19, 10.19, 10.19); Calibrated: 30.12.2017;

• Sensor-Surface: 1.4mm (Mechanical Surface Detection)

• Electronics: DAE4 Sn601; Calibrated: 26.10.2017

Phantom: Flat Phantom 4.9 (Back); Type: QD 00R P49 AA; Serial: 1005

• DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

#### Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

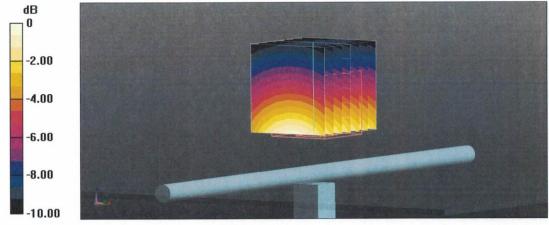
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 57.48 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 3.15 W/kg

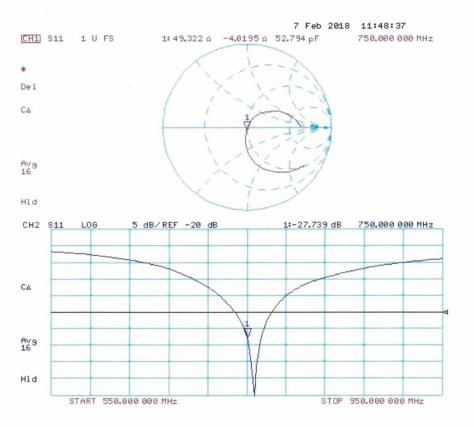
SAR(1 g) = 2.14 W/kg; SAR(10 g) = 1.42 W/kg

Maximum value of SAR (measured) = 2.80 W/kg



0 dB = 2.80 W/kg = 4.47 dBW/kg

#### Impedance Measurement Plot for Body TSL



# **Extended Dipole Calibrations**

Referring to KDB865664 D01, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

Head-750						
Date of	Dotum loss (dD)	Dolto (0/)	Real Impedance	Delta	Imaginary	Delta
measurement	Return-loss (dB)	Delta (%)	(ohm)	(ohm)	impedance (ohm)	(ohm)
2018/2/7	-28.1		54.1		-0.2	
2019/2/3	-27.5	2.14%	53.5	0.6	-0.5	0.3
2020/1/22	-27.7	1.42%	53.2	0.9	-0.6	0.4

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 50hm of prior calibration. Therefore the verification result should support extended calibration.

### 1.3. D835V2 Dipole Calibration Certificate

Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





S Schweizerischer Kalibrierdienst
Service suisse d'étalonnage
Servizio svizzero di taratura

**Swiss Calibration Service** 

Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

The Swiss Accreditation Service is one of the signatories to the EA

Multilateral Agreement for the recognition of calibration certificates

Client

CCIC-HTW (Auden)

Certificate No: D835V2-4d238\_Feb18

<b>ALIBRATION CE</b>			
bject	D835V2 - SN:4d23	38	
calibration procedure(s)	QA CAL-05.v9 Calibration proced	lure for dipole validation kits abov	e 700 MHz
Calibration date:	February 19, 2018	3	
All calibrations have been conduc		y facility: environment temperature (22 ± 3)°C	Scheduled Calibration
Primary Standards	ID#	Cal Date (Certificate No.)	Scrieduled Calibration
I Illiary Clarical Se			Apr-18
Power meter NRP	SN: 104778	04-Apr-17 (No. 217-02521/02522)	Apr-18 Apr-18
	SN: 104778 SN: 103244	04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521)	Apr-18
Power sensor NRP-Z91		04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522)	Apr-18 Apr-18
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator	SN: 103244 SN: 103245 SN: 5058 (20k)	04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528)	Apr-18
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination	SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327	04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529)	Apr-18 Apr-18 Apr-18
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator	SN: 103244 SN: 103245 SN: 5058 (20k)	04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528)	Apr-18 Apr-18 Apr-18 Apr-18
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4	SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601	04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)	Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards	SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601	04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17) Check Date (in house)	Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check In house check: Oct-18
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A	SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601	04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house)	Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check In house check: Oct-18 In house check: Oct-18
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A Power sensor HP 8481A	SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB37480704 SN: US37292783	04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16)	Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check In house check: Oct-18 In house check: Oct-18 In house check: Oct-18
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A	SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB37480704 SN: US37292783 SN: MY41092317	04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16)	Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check In house check: Oct-18
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4  Secondary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB37480704 SN: US37292783 SN: MY41092317 SN: 100972	04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16)	Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check In house check: Oct-18 In house check: Oct-18 In house check: Oct-18
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A	SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB37480704 SN: US37292783 SN: MY41092317	04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16)	Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18  Scheduled Check In house check: Oct-18
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB37480704 SN: US37292783 SN: MY41092317 SN: 100972	04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16) 18-Oct-01 (in house check Oct-17)	Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18  Scheduled Check In house check: Oct-18
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601  ID #  SN: GB37480704 SN: US37292783 SN: MY41092317 SN: 100972 SN: US37390585	04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16) 18-Oct-01 (in house check Oct-16)	Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18  Scheduled Check In house check: Oct-18

Issued: February 19, 2018

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: D835V2-4d238\_Feb18

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### Calibration Laboratory of

Schmid & Partner **Engineering AG** Zeughausstrasse 43, 8004 Zurich, Switzerland





Schweizerischer Kalibrierdienst

Service suisse d'étalonnage C Servizio svizzero di taratura

Accreditation No.: SCS 0108

S **Swiss Calibration Service** 

Accredited by the Swiss Accreditation Service (SAS)

The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

#### Glossary:

TSL

tissue simulating liquid

ConvF N/A

sensitivity in TSL / NORM x,y,z not applicable or not measured

# Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### Additional Documentation:

e) DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

- Measurement Conditions: Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss: These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay: One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured: SAR measured at the stated antenna input power.
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Certificate No: D835V2-4d238\_Feb18

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### **Measurement Conditions**

DASY system configuration, as far as not given on page 1.

ASY system configuration, as far as not (	DASY5	V52.10.0
DASY Version		
Extrapolation	Advanced Extrapolation	
	Modular Flat Phantom	
Phantom Distance Dipole Center - TSL	15 mm	with Spacer
	dx, $dy$ , $dz = 5 mm$	
Zoom Scan Resolution	835 MHz ± 1 MHz	
Frequency	000 1111 12 2 1 1111 12	

**Head TSL parameters** 

The following parameters and calculations were applied.

he following parameters and calculations were appli	Temperature	Permittivity	Conductivity
. = 0.1	22.0 °C	41.5	0.90 mho/m
Nominal Head TSL parameters	(22.0 ± 0.2) °C	41.2 ± 6 %	0.92 mho/m ± 6 %
Measured Head TSL parameters  Head TSL temperature change during test	< 0.5 °C		

## SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
	250 mW input power	2.42 W/kg
SAR measured	normalized to 1W	9.51 W/kg ± 17.0 % (k=2)
SAR for nominal Head TSL parameters	normalized to 144	0.00

10 cm3 (10 g) of Head TSL	condition	
SAR averaged over 10 cm³ (10 g) of Head TSL	250 mW input power	1.56 W/kg
SAR measured		6.15 W/kg ± 16.5 % (k=2)
SAR for nominal Head TSL parameters	normalized to 1W	6.15 W/kg ± 10.0 /5 (11 =/

**Body TSL parameters** 

ne following parameters and calculations were appli	Temperature	Permittivity	Conductivity
	22.0 °C	55.2	0.97 mho/m
Nominal Body TSL parameters	(22.0 ± 0.2) °C	55.0 ± 6 %	0.99 mho/m ± 6 %
Measured Body TSL parameters			
Body TSL temperature change during test	< 0.5 °C		

## SAR result with Body TSL

Condition		
Condition		
250 mW input power	2.45 W/kg	
	9.64 W/kg ± 17.0 % (k=2)	
normalized to 1VV	3.04 W/kg = 1110 /4 (***)	
	Condition 250 mW input power normalized to 1W	

12 m <sup>3</sup> (10 m) of Rody TSI	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	250 mW input power	1.60 W/kg
SAR measured	normalized to 1W	6.32 W/kg ± 16.5 % (k=2)
SAR for nominal Body TSL parameters	Hormanzou to 111	

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# Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.8 Ω - 4.0 jΩ
Impedance, transformed to reed point	07.0 dD
Deturn Loss	- 27.8 dB
Return Loss	

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.6 Ω - 6.0 jΩ	
Impedance, transformed to feed point	- 23.6 dB	
Return Loss	- 23.6 dB	

## **General Antenna Parameters and Design**

LD L (and direction)	1.391 ns
Electrical Delay (one direction)	

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

#### **Additional EUT Data**

Mary for showed by	SPEAG
Manufactured by	Lune 00, 2017
Manufactured on	June 02, 2017
Manufactured on	

Certificate No: D835V2-4d238\_Feb18

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### **DASY5 Validation Report for Head TSL**

Date: 19.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d238

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used: f = 835 MHz;  $\sigma$  = 0.92 S/m;  $\epsilon_r$  = 41.2;  $\rho$  = 1000 kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY52 Configuration:

Probe: EX3DV4 - SN7349; ConvF(9.9, 9.9, 9.9); Calibrated: 30.12.2017;

• Sensor-Surface: 1.4mm (Mechanical Surface Detection)

• Electronics: DAE4 Sn601; Calibrated: 26.10.2017

Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001

• DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

# Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

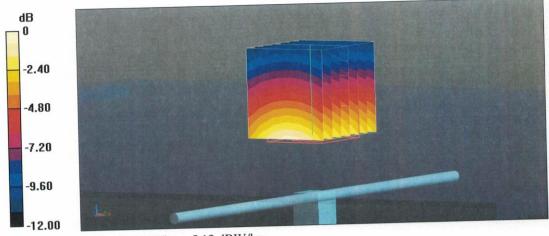
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 62.44 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 3.69 W/kg

SAR(1 g) = 2.42 W/kg; SAR(10 g) = 1.56 W/kg

Maximum value of SAR (measured) = 3.25 W/kg

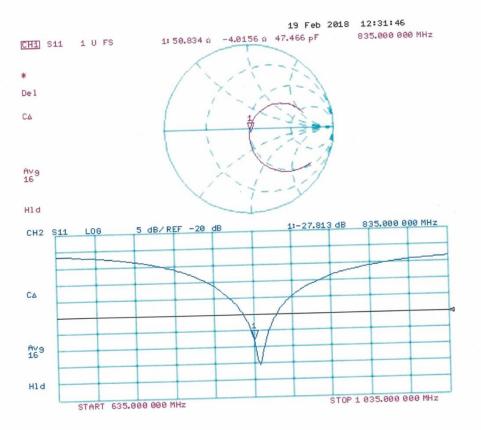


0 dB = 3.25 W/kg = 5.12 dBW/kg

Certificate No: D835V2-4d238\_Feb18

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# Impedance Measurement Plot for Head TSL



Certificate No: D835V2-4d238\_Feb18

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## **DASY5 Validation Report for Body TSL**

Date: 19.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d238

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used: f = 835 MHz;  $\sigma$  = 0.99 S/m;  $\epsilon_r$  = 55;  $\rho$  = 1000 kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY52 Configuration:

Probe: EX3DV4 - SN7349; ConvF(10.05, 10.05, 10.05); Calibrated: 30.12.2017;

• Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn601; Calibrated: 26.10.2017

Phantom: Flat Phantom 4.9 (Back); Type: QD 00R P49 AA; Serial: 1005

DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

# Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

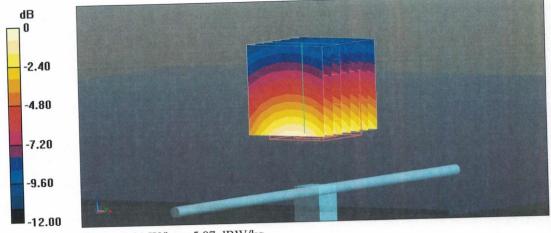
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 60.24 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 3.70 W/kg

SAR(1 g) = 2.45 W/kg; SAR(10 g) = 1.6 W/kg

Maximum value of SAR (measured) = 3.21 W/kg

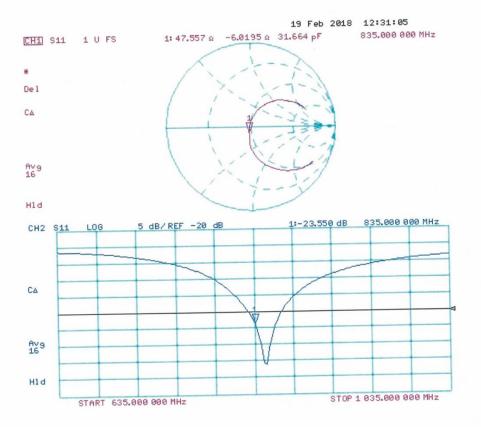


0 dB = 3.21 W/kg = 5.07 dBW/kg

Certificate No: D835V2-4d238\_Feb18

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## Impedance Measurement Plot for Body TSL



Certificate No: D835V2-4d238\_Feb18

# **Extended Dipole Calibrations**

Referring to KDB865664 D01, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

			Head-835			
Date of	Deturn lose (dD)	Dolto (0/)	Real Impedance	Delta	Imaginary	Delta
measurement	Return-loss (dB)	Delta (%)	(ohm)	(ohm)	impedance (ohm)	(ohm)
2018/2/19	-27.8		50.8		-4.0	
2019/2/3	-27.1	2.52%	49.9	0.9	-3.6	0.4
2020/1/22	-26.9	3.24%	50.2	0.6	-3.7	0.3

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 50hm of prior calibration. Therefore the verification result should support extended calibration.

### 1.4. D1750V2 Dipole Calibration Certificate

Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





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Swiss Calibration Service

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Client

**CCIC-HTW (Auden)** 

Certificate No: D1750V2-1164\_Feb18

bject	D1750V2 - SN:11	64		
alibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz			
alibration date:	February 06, 201	8		
his calibration certificate docume	ents the traceability to nati	onal standards, which realize the physical un	its of measurements (SI).	
		robability are given on the following pages ar		
I calibrations have been conduct	ted in the closed laborato	ry facility: environment temperature (22 ± 3)°	C and humidity < 70%.	
alibration Equipment used (M&T	E critical for calibration)			
	I	O I Data (O at/Santa Na )	Scheduled Calibration	
rimary Standards	ID#	Cal Date (Certificate No.)	Apr-18	
ower meter NRP	SN: 104778	04-Apr-17 (No. 217-02521/02522)	Apr-18	
ower sensor NRP-Z91	SN: 103244	04-Apr-17 (No. 217-02521)	Api-10	
	011 400045	04 A 47 (No. 017 00500)	Apr-18	
ower sensor NRP-Z91	SN: 103245	04-Apr-17 (No. 217-02522)	Apr-18	
ower sensor NRP-Z91 eference 20 dB Attenuator	SN: 5058 (20k)	07-Apr-17 (No. 217-02528)	Apr-18	
ower sensor NRP-Z91 eference 20 dB Attenuator ype-N mismatch combination	SN: 5058 (20k) SN: 5047.2 / 06327	07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529)	Apr-18 Apr-18	
ower sensor NRP-Z91 eference 20 dB Attenuator ype-N mismatch combination eference Probe EX3DV4	SN: 5058 (20k)	07-Apr-17 (No. 217-02528)	Apr-18	
ower sensor NRP-Z91 eference 20 dB Attenuator ype-N mismatch combination eference Probe EX3DV4 AE4	SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601	07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)	Apr-18 Apr-18 Dec-18 Oct-18	
ower sensor NRP-Z91 deference 20 dB Attenuator gype-N mismatch combination deference Probe EX3DV4 dAE4	SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601	07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17) Check Date (in house)	Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check	
ower sensor NRP-Z91 eference 20 dB Attenuator ppe-N mismatch combination eference Probe EX3DV4 AE4 econdary Standards ower meter EPM-442A	SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601	07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17) Check Date (in house)	Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check In house check: Oct-18	
ower sensor NRP-Z91 eference 20 dB Attenuator ype-N mismatch combination eference Probe EX3DV4 AE4 econdary Standards ower meter EPM-442A ower sensor HP 8481A	SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601  ID #  SN: GB37480704 SN: US37292783	07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house)  07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16)	Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check In house check: Oct-18 In house check: Oct-18	
ower sensor NRP-Z91 deference 20 dB Attenuator gype-N mismatch combination deference Probe EX3DV4 dAE4 decondary Standards dower meter EPM-442A dower sensor HP 8481A	SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601  ID #  SN: GB37480704 SN: US37292783 SN: MY41092317	07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house)  07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16)	Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check In house check: Oct-18 In house check: Oct-18 In house check: Oct-18	
Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Recondary Standards Power meter EPM-442A Power sensor HP 8481A RF generator R&S SMT-06	SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601  ID #  SN: GB37480704 SN: US37292783 SN: MY41092317 SN: 100972	07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house)  07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16)	Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check In house check: Oct-18 In house check: Oct-18	
Reference Probe EX3DV4 DAE4 DAE4 DAE4 DAE4 DAE4 DAE4 DAE4 DAE	SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601  ID #  SN: GB37480704 SN: US37292783 SN: MY41092317	07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house)  07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16)	Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check In house check: Oct-18	
ower sensor NRP-Z91 eference 20 dB Attenuator ype-N mismatch combination eference Probe EX3DV4 AE4 econdary Standards ower meter EPM-442A ower sensor HP 8481A F generator R&S SMT-06	SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601  ID #  SN: GB37480704 SN: US37292783 SN: MY41092317 SN: 100972	07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house)  07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16)	Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check In house check: Oct-18 In house check: Oct-18 In house check: Oct-18 In house check: Oct-18	
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Recondary Standards Rec	SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601  ID #  SN: GB37480704 SN: US37292783 SN: MY41092317 SN: 100972 SN: US37390585	07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house)  07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16) 18-Oct-01 (in house check Oct-17)	Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check In house check: Oct-18	
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Recondary Standards Rec	SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601  ID #  SN: GB37480704 SN: US37292783 SN: MY41092317 SN: 100972 SN: US37390585  Name	07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house)  07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16) 18-Oct-01 (in house check Oct-17)  Function	Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check In house check: Oct-18	
Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Recondary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A	SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601  ID #  SN: GB37480704 SN: US37292783 SN: MY41092317 SN: 100972 SN: US37390585  Name	07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house)  07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16) 18-Oct-01 (in house check Oct-17)  Function	Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check In house check: Oct-18 Signature	

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